Flood hazard Mapping Project in China

Concluding Report For

JICA region-focused training course on flood hazard mapping

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1. Background and objective of the planned project

1.1 Current situation

China is endowed with about 50,000 rivers, including 1,600 rivers with water basin larger than 1,000 km2 each. The topography of China is characterized by high west part and low east part, gradually descending in elevation from the west towards the east to form three steps. The main river systems consist of seven major rivers, the Yangtze, Yellow, Pearl, Haihe, Huaihe, Liaohe and Songhua rivers. Most rivers, including seven major rivers, flow from west to east, directly or indirectly emptying into the Pacific Ocean. And the total annual average runoff is about 2,800 billion m3.

China is subject to strong monsoon climate and most of the areas are under the impacts of the southeastern and southwestern monsoons. The average annual precipitation in China is 648 mm. About 70% of annual rainfall is concentrated in the flood season lasting from June to September in most area. The floods have the characteristic of high peak discharge and great amount of flood volume. The water volume of one large flood may account for the annual runoff of the river. The extremely uneven temporal and spatial distribution of precipitation and river runoff constitute the fundamental cause of frequent floods and waterlogging in flood season.

Floods occurred frequently in China. According to statistics, in the past two thousand years, nearly one thousand comparable large floods have occurred altogether, and one flood disaster occurred in two years in average. During the 1990s, six out of 10 years witnessed major floods taking place in the major river basins. In some areas, floods occur every year. On average, there are seven typhoons that land on the mainland of China every year. Torrential rains also cause mudflow and landslide problems. The total flood-prone areas are about 1.06 million km2, nearly 11 percent of Chinese territory. In these areas there is a population of 840 million people, and GDP is about 6562.8 billion RMB. These areas are the major regions of Chinese social and economic activities.

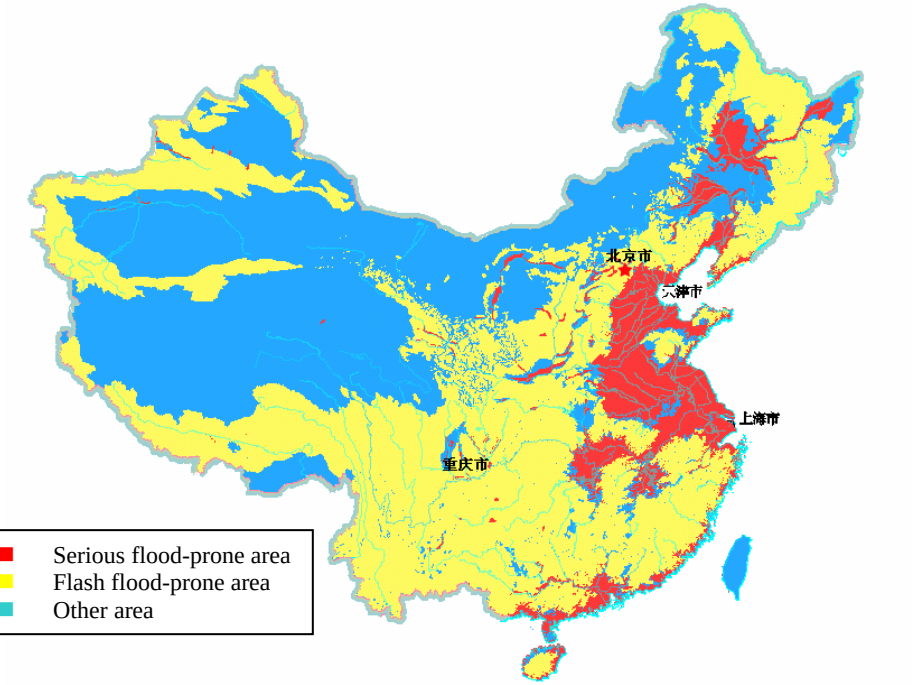

Figure 1 Regions of different flood hazard

In 1990s, annual economic losses caused by floods accounted for 1.7% of GDP. But in developed countries the flood damage rate to GDP is less than 0.5%.

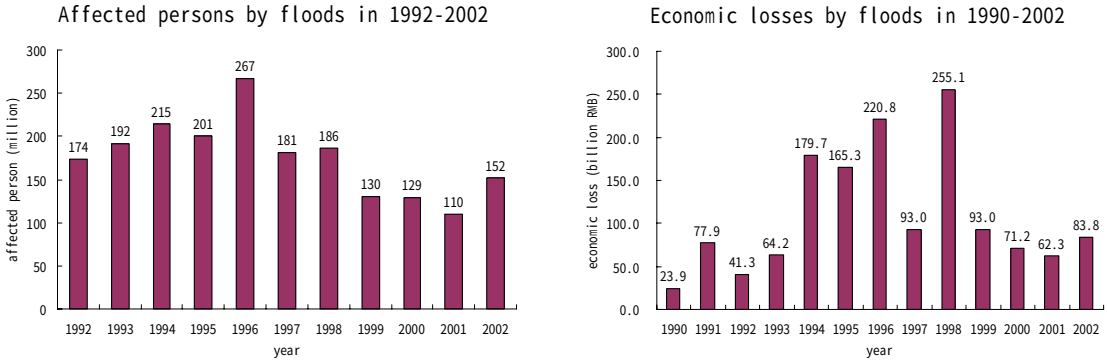

Figure 2 Flood losses of China in 1990-2002

The injury, death and property losses caused by floods, landslide and mudflow, rank the first among all natural disasters in China. Floods seriously threaten the social and economic development. As a significant strategic issue, flood control and flood security attract high attention all over the country.

1.2 present countermeasures for mitigating flood damages

In the late 20th century, the floods in the Yangtze, Nenjiang and Songhuajiang rivers in 1998 were the most serious natural disasters. China made great efforts to implement the project to prevent floods. In China the flood control systems are composed of structural and non-structural measures. Combined these measures, the main goal of flood management is prevention of casualties and reduction of economic losses to the least.

Structural measures are aimed at releasing, detaining, confining, diverting and storing floodwater, to reduce the frequency and magnitude of flooding. Flood control

facilities construction in the river basin is the basic way to mitigate flood risk and damage. These facilities include reservoirs, embankments, food detention areas, pumping stations, etc. Reservoirs were constructed in upstream areas to store floodwaters and decrease flood peak, to reduce flood magnitude. Levees and embankments along the rivers were constructed to confine extents of inundation. Flood detention areas, for temporary storage of floodwaters to control discharge to downstream, were built up in the lower rivers.

With the effort of fifty years, the comparable integrated flood and waterlogging mitigation system, which can control normal flood disasters, had been accomplished. It can be summarized as follows: about 246-thousand kilometers levees and embankments constructed; more than 860-thousand reservoirs with a total storage capacity more than 475.1-billion cubic meters; 98 national specified flood detention areas with total capacity near 100-billion cubic meters. According to incompletion statistics, the flood prevention system that has been built has reduced losses of 1,500 billion RMB from floods.

Up to now, the key flood control projects were constructed up in seven major rivers in China. The Xiaolangdi reservoir located at the lower Yellow River commenced its operation in 2000, to control floods and reduce aggradation rate in the lower Yellow River. Three Gorges Project will be completed. In Huaihe River, Linhuaigang hydraulic complex project has been constructed, which improve the flood control standard in the middle reach of Huaihe River to 100-year flood.

Non-structural measures play a very important role in China. These methods include legal and institutional system, recovery of floodplain storage, flood forecasting and telecommunication system, flood emergency planning and response, and post-flood recovery, etc. These activities directly modify the vulnerability of communities exposed to flood risk.

Till now, China has set up a series of flood control legal and institutional system. Flood Control Law was adopted on August. 29 1997, and came into force on January.1 1998. According to the law, all units and individuals shall have the obligations to protect flood control works and to take part in flood control and flood fighting. The administrative heads of people's governments at all levels have the obligation to assume overall responsibility for the work of flood control, this is the basic rule in Chinese flood management. So the local government, such as province, city and county, should be in charge of flood facilities construction and flood fighting. And central government and Ministry of Water Resources provide capital and technical support separately to the local government. Defense planning for the Seven Large Rivers are compiled by State Flood Control and Drought Relief Headquarters, which comprise the operation principle of flood facilities and the flood fighting obligation of local government concerned.

Recovery of floodplain storage in river systems is also used to increase flood storage capacity. After 1998 flood of Yangtze River, farmlands around the Poyang Lake and Dongting Lake, the two largest lakes in middle stream of Yangtze river, are returned to recover lakes and rivers, 2.42 million affected populations were resettled to nearby places, water area of 2900 km2 was recovered and flood storage capacity of 13 billion cubic meters was increased.

Flood forecasting is another non-structure measure widely used in China. Hydrological information system can collect and disseminate hydrological

information promptly, and make hydrological forecasting. The real-time rainfall and flood information of the national hydrological stations can be collected within 30 minutes, and forecasting results can be obtained within 1 hour. The hydrological information is the most important data for flood-decision. Research is ongoing to maintain and improve technical capabilities.

In addition, China has formulated a compensation policy for the local people living inside flood detention areas since 2000. Central and local governments share the expenses on personal property and crop loss compensation due to flood detention in the national flood detention areas. In the past five years, ten flood detention areas were utilized to storage floods, nearly 200 million RMB capitals were compensated for the affected residents.

In 1998, extraordinary severe floods occurred in the Yangtze River basin. Flood-control system construction for rivers is oriented towards harmonious coexistence between man and nature. In other words, floods should be provided a way out, and thoughts should be gradually transformed from endless disorderly struggle for land between man and water to orderly and sustainable harmony between man and flood. A new flood thoughts, transfer from the flood control to flood management, has been brought forward since 2003. So In the process of flood management, flood, drought and water shortage issues are considered concurrently, firstly to ensure the flood safety, and utilize the flood source to mitigate water shortage.

1.3 The objectives of flood hazard mapping

Since flooding is a natural phenomenon, it's impossible to prevent flood disasters completely. Although structural measures can control the target floods, in a case where floods exceed target level, the structure measures still could not prevent the occurrence of flood damage. So there is a need for non-structure measure to cope with the floods that exceed the target level, and flood hazard map is a good example of such non-structural measures. flood hazard maps are developed as a multiple-purpose project, expected to achieve several objectives.

First objective is to enhance awareness of flood disaster prevention of the target area. "Becoming aware is the step towards preparation". When floods occur, disaster mitigation not only relies on the government activities, but also community and self-help. In areas where flooding has been decreased by flood control facilities, or not suffered from flooding in recent years, the residents tempt to be too optimistic and believe there is no flood danger in the area. It's very necessary to offer flood disaster mitigation education to the public. From flood hazard map, it can awake residents that they still live in the flood-prone area, and the public can obtain effective flood and evacuation information, so it impels residents to think for themselves, bearing in mind the danger of flood damage and to prepare beforehand. As a result, in the emergency of flooding, residents can evacuate in time and reduce the damage loss by themselves.

Secondly, flood hazard map can serve for the flood control and flood fighting decision-making. In the process of compiling flood hazard maps, such as examining disasters or gathering various kinds of information, FCH can collect more information about flood inundation, acquire experience on how to evacuate residents promptly, enable prompt administration of action on the occasion of the

actual flood. And also flood hazard map can be used to offer basic data for assessing flood losses. In the emergency of flooding, important information, such as previous inundation area, affected people, economic loss, can be estimated in advance, so FCH can determine how to operate flood control facilities, such as reservoirs, flood detention areas, and issue evacuation order in time.

Thirdly, flood hazard map can direct the land use plan and construction of safety facilities in the target area. Flood hazard maps provide a principle for land use plan. In the presumed deep inundation area, it's restricted to develop industry immoderately, otherwise these factories should construct self-guard flood control facilities to ensure safety. And the flood hazard maps can provide reference for land use plan, such as which area is suited for agriculture, industry, entertainment, wetland, etc. There are many people living inside 98 flood diversion and detention areas in China. In order to safeguard their lives at flooding times, live-saving facilities have been constructed, and flood hazard map can provide choose visual and reasonable way and place for evacuating people in emergency.

Finally, using flood hazard maps, flood damage can be reduced by the accurate information and usual countermeasures. The residents know how to get flood information and where, when, how to evacuate, it can shorten evacuation time effectively. Lives will be saved by early escape.

1.4 The roles in flood hazard mapping

1.4.1 Responsibility for making anticipated inundation maps

The Ministry of Water Resources (MWR) is the ministry of the State Council that is responsible for water administration. One of main responsibilities of MWR is in charge of planning, construction and management of flood control measures. Office of State Flood Control and Drought Relief Headquarters (OSFCDRH) is the special department in charge of national flood affairs in MWR, and also to take the daily work for its Headquarters. Bureau of Hydrology (BOH) is another department of MWR, which provides hydrological, precipitation information and technical support for OSFCDRH.

In China, seven major rivers flow different provinces, in order to coordinate and conduct water-related affairs, River Basin Water Resources Commissions (RBWRC) for the Yellow River, Yangtze River, Hai River, Huai River, Pearl River, SongLiao River and Taihu Lake, have been established. Specific functions for water management and flood protection, such as drafting out flood control planning for major rivers, are implemented through these commissions. For the convenient flood management of river basins, the Yangtze, Yellow, Huaihe and Songhua River have separately established a basin-wide flood control organization, which is under the leadership of SFCDRH. Flood Control and Drought Relief Headquarters at local levels are in charge of flood emergency response affairs at the river basin or the local level.

In my opinion, MWR, OSFCDRH, BOH and RBWRC should take the responsibility for make anticipated inundation area maps of seven major rivers. These institutions have collected the flood disaster information of these rivers, and also are familiar to the flood control planning and facilities. So they can calculate and simulate the inundation area and depths, compile the record and anticipated inundation maps

and provide these maps to the respective provincial governments. Provincial Bureau of water resources, and Office of Provincial Flood Control Headquarters are in charge of other rivers flood inundation maps in the jurisdiction. China Institute of Water Resources and Hydropower Research will also play an important role on technical support for the flood inundation and hazard maps.

Flood anticipated inundation maps are mainly used by officials and technicians concerned and provide basic datum and flood information.

1.4.2 Responsibility for making and disseminating flood hazard maps

In China, governors of local governments, such as province, city and county, are stipulated as the executive official in charge of the local disaster prevention and flood fighting. So the local governments are authorized to issue evacuation orders and supply accommodation for the affected residents. Local governments are familiar to the residents' distribution and topography of its jurisdiction. So it's the local government responsibility to make and disseminate flood hazard maps. Flood hazard map are aimed at the public living in the flood prone areas, to prevent casualties by providing residents with flooding and evacuation information a easy-understanding way.

In detail, Bureau of water resources and Office of Flood Control Headquarters of the local government bear the concrete works, in close cooperation with the local residents, qualified experts, non-governmental organizations and other pertinent bodies.

1.5 Problems of making flood hazard maps

According my cognition, there is no unsolvable technical problem in producing flood hazard maps, but it is time and capital consuming work. The most important things are whether we can collect detailed datum and develop advanced hydrological numerical calculation, and also the experience is also indispensable.

There are four problems we may probably encounter in the process of producing flood hazard maps.

(1) Lack of laws support. Flood Control Law of People's Republic of China came into force as of January, 1998, but no such provision about flood risk and hazard maps were stipulated in the law. So it's not an obligation for local governments to produce flood hazard maps, if local governments are lack of enthusiasm or capital, they may not impel this work.

(2) Large Flood inundation area. Some important embankments of lower major rivers protect wide lands and many residents, and the flood level is several meters higher than the inland ground level. Residents live sporadic in this area and the transportation is not convenient, the farthest evacuation routine may exceed 10 km, so the evacuation time will be very long. In these protective areas, if the levees are broken, large areas and thousands of residents will be inundated, how to estimate the inundation area and establish the evacuation plan is a difficult problem. We should estimate the anticipated inundation area according to the volume of flood water discharging from the levee breaks.

(3) Low flood control standard. Because flood control standard of many levees can only prevent the flood which occurs once in 10 years, in my opinion, 10-year, 20-year, 50-year, 100-year flood, and maximum flood inundation areas should be drawn out in the maps with different colors, so and risk of different flood magnitude can be displayed.

(4) Lack of detail information and experience. Although China Institute of Hydraulic and Hydropower Research is pursuing in the flood risk study, they have taking several pilot study about flood risk, yet this study has not been demonstrated by actual floods. And production of flood hazard maps just starts, now there is no flood hazard map completed.

2. Target area

We select Mengwa flood detention area as target area to apply a flood hazard map. Mengwa flood detention area is located in the boundary of the upper and middle reach of Huaihe River. It is the most frequent one of utilization to reduce the flood flow. So Mengwa flood detention area is planned to apply flood hazard map.

Mengwa flood detention area is situated in the southeast of Funan County, Anhui Province, which lies on the north bank of middle Huaihe River. The total area is 180 km^2, with farmland of 120 km^2. There are near 150 thousand people living in the area, and the total property value is about 1.2 billion RMB. The average annual rainfall in this area is 800~1000mm. The rainfall from Jun. to Sep. accounts for about 60% of annual rainfall.

The Mengwa flood detention area was built in 1953. There are about ten evacuation roads totaled 92.4 kilometers, 129 earth platforms and 4 embankment village polders in Mengwa flood detention area. The total area of the earth platforms is 2.44 million square meters, and embankment village polders totals 4.9 square kilometers. All the people can be resettled in these zones.

During the past 54 years following, the Wangjiaba sluice gates had been opened 12 times in ten years. In 1991, the sluice gates were opened twice to divert floodwaters, submerging the Mengwa area for the entire summer and autumn.

In 2003, large flood occurred in the Huaihe River. On July 3, the level of Wangjiaba hydrological station reached 29.39m, exceeding the diverting level of 29.0m. Meangwa flood detention area was utilized to storage floodwater lately. people have been evacuated to the earth platforms and embankment village polders.

On July 12, 2005, floods took place in the Huaihe River. The flood level of Wangjiaba gauge station reached to 29.14 m, exceeding 29.0m level of flood diversion. Since the weather forecasted it was sunny in the following two days, and there were no dangerous zones occurring on the embankments. SFCDRH decided not to utilize the Mengwa flood detention area to divert floods, avoiding farmland losses of 120 square kilometers. According the Provisional Regulations of Loss Compensation in the Specified Flood Detention Areas, the personal property and crop loss due to flood detention were compensated by central and Anhui provincial government.

In 2007, Huaihe River appeared big flood again. Because of longtime heavy rain, Wangjiaba gauge station water level is above 29.3m on July 10. In order to

decrease the flood fighting pressure of the upper and lower reach of Wangjiaba gauge station, SFCDRH decided to use Mengwa flood detention.

Figure 3.Mengwa flood detention inundated

3. Project schedule

	item	time
1	Collecting data	2008.1~2008.6
2	Flood risk analysis	2008.6~2008.8
3	Mapping	2008.8~2008.10
4	Dissemination	2008.11~2008.12

4. Concrete implementation items of the schedule

4.1 Collecting data

- Collecting past floods information, and Compiling history inundation maps;
- Collecting base map with 1:10000 or larger scale ;
- Collecting social and economic data(population, GDP)
- Collecting hydrological and meteorologic data
- Collecting flood damage data;
- Collecting flood engineerings information;
- Collecting evacuation site and route information;
- Collecting land use information.
- Collecting flood dispatching plan(river, reservoir, detention, sluice)

4.2 Flood risk analysis

Through hydrological and hydraulic calculation and simulation, estimate the

anticipated inundation areas, such as extent of inundation, water depth, flow rate, arrival timing etc.

4.3 Mapping

- Inquire all stakeholders' suggestion or opinion(resident, central government, province administration, province administration,community)
- Calculating population required to evacuate, accommodation provided by shelters
- Formulation evacuation plan
- Compile flood hazard maps

4.4 Dissemination

- Disseminating map to each household in inundation area
- Disseminating map to each level administration

5. Expected benefit and progress for residents and administrators

5.1 Expected benefit and progress for residents

- Residents' awareness of flood disaster prevention will be greatly increased
- Residents easily know how to get flood information and where, when, how to evacuate, evacuation time will be shorten effectively.
- Residents' self-help and mutual-support ability will be improved.

5.2 Expected benefit and progress for administrators

- Government's public assistant ability will be improved.
- Flood hazard map can serve administrators for the flood control and flood fighting decision-making.
- Flood hazard map can contribute to the land use plan and construction of safety facilities

6. Approximate cost estimate

	item	Cost(USD)
1	Collecting data	200,000
2	Flood risk analysis	150,000
3	Mapping	100,000
4	Dissemination	50,000
sum		500,000

7. Suggestion and opinion for FHM training course

We should express our sincere thanks to JICA, TBIC, PWRI and ICHARM. This training greatly improves our knowledge of flood hazard maps, let us know how to effectively make, disseminate, utilize flood hazard map. All these will also benefit flood management of China in the future.

There are two suggestions:

- If possible, please arrange trainees to visit MLIT, let trainees further get to know the water-related administrative management in Japan.
- China is one of the countries suffered severe water-related disasters, and we hope to exchange information and share experiences with Japan and other countries. We are expecting JICA, TBIC, PWRI and ICHARM will offer chance for Chinese participants to attend alike course.